INTERNATIONALIZATION AND INNOVATION: THE CHALLENGES FOR EUROPE IN A CHANGING WORLD

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A large part of the economic literature is unanimous in believing technological progress and openness to foreign trade are key variables to trigger the processes of stable and persistent economic growth. An in-depth analysis of these factors, thus, becomes necessary both to meet the challenges of the international market, and to strengthen the European integration process.
This paper aims to provide an empirical analysis of the interaction between foreign trade and technological progress by performing a multidimensional scaling. This technique is used to produce a graphical representation of the 27 EU member states, in accordance to the degree of similarity or dissimilarity between them.
The indicators used, and the indexes calculated, reflect the different degree of internationalization of each country's economy, the regulation of trade flows, investment in specific R&D and technological progress.

Keywords: International trade, integration, technological progress

JEL code: F1, F4, O1

1. Introduction

Arguably, investment in research and development – either of public or private nature - is the main engine of innovation and progress in technology and one of the crucial sources of sustainable and stable growth over the long term.
Throughout history, economic growth has unfolded in a number of progressive stages, marked by dramatic improvements in technology, which have allowed direct increases in labour productivity and ensured growth and greater prosperity for larger and larger shares of population.
Technological progress has been included in major studies in the field of economic growth, both within the neoclassical approach (Solow 1956) and the more recent endogenous growth theory (Lucas 1988; Romer 1990), that best explained the processes of technical change and growth by using the proper economic tools of analysis. As this literature predicts, improvements in technology available to workers are able to generate prolonged economic growth, especially when technologically advanced means are used by a highly skilled labour force.
Of course, the developmental stage of the economy makes the process of investment in research and innovation non-homogeneous, which may consequently impact on growth rates with different outcomes. This means that special conditions must exist for which the productive investments above mentioned have the desired effects.
In the context of economic growth a significant role is played by exports, which positively affect the long-run rate of growth through a variety of channels. By building and

strengthening relationships with foreign partners, countries may gain comparative advantages, have incentives to specialize in larger markets, exploit appropriate economies of scale, and absorb technology and knowledge from abroad.
In this connection, Grossman and Helpman (1991) analyse the positive effect of openness to foreign trade, not only as being induced by the exchange of technologies and ideas (Chuang 1998), but also as resulting from effect of increased competition in wider markets, with the need to invest in research and development in order to retain competitive advantages and improve efficiency.
In addition, companies that decide to participate in international trade are those that may gain productivity advantages through constructive processes, such as learning-by-exporting (Goldberg & Pavnik 2007). Other studies (Young 1991) focus on the role played by learning-by-doing, which results from specialization and optimization of production. Human capital has also come into prominence as a major source of market integration (Chuang 2000; Frantzen 2000; Wang 2007).
An important channel for the exchange and circulation of knowledge is, therefore, represented by international trade. In this context a central role is played by information and communication technologies in a twofold manner: on the one hand, they have enabled the expansion of economic relations, on the other they represent a growing share of global trade. There is, indeed, a reciprocal relationship: exchanges allow the acquisition of more knowledge, and this favours in turn the process of import-export. In this light, exports of ICTs represent an indicator of technological progress, for only countries that have continuously committed resources to R&D over the years can compete in a difficult and evolving market and be successful in this sector. The U.S. are an enlightening example, being net exporters only in the most technologically advanced sectors.
This notwithstanding, economically backward countries have the opportunity to receive knowledge and technologies through transnational exchanges, without incurring the initial cost of developing innovations.

2. Methodology and results

Multidimensional scaling (MDS) is a useful tool through which it is possible to produce a graphical representation of a pattern of objects, in this case the 27 EU member countries, based on the degree of similarity/dissimilarity between them.
The goal is to provide a representative map that best approximates the distances observed between countries, concerning international market openness, barriers to foreign trade, investment in specific research and support to technological progress.
This statistical method attempts to build a configuration of the various entities, merged in a small number of dimensions. This is done by defining relations between countries in terms of proximity/distance with respect to the indicators considered. The resulting positioning map has the property to partition the countries into homogeneous groups, so as that the degree of association between two countries is maximal if they belong to the same group and minimal otherwise.
We considered a matrix of 27 countries and 9 indicators, representing 3 distinct sets of variables: openness to international trade, trade barriers and investment in R&D and human capital (Tab. 3). The model's goodness of fit was assessed via the RSQ[134] (0,95) and the S-Stress[135] (0,10). The two-dimensional model was judged to be acceptable according to the values of the Kruskal's Stress index, reported in Table 1. Further investigation provided additional basis for choosing a two-dimensional solution: the "elbow" rule suggests to choose the number of dimensions in

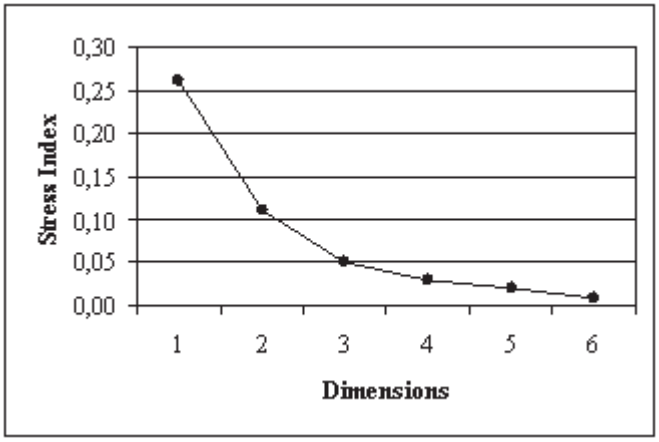
[134] RSQ indicates the proportion of variability explained by the corresponding dissimilarity distances.
[135] As general rule, results are found to be robust when the size k achieves an S-stress value lower than 0,15.

correspondence to where the diagram yields an "elbow", beyond which the broken line flattens (Fig. 1).

Tab. 1 – Stress index and map configuration

Dimensions	Stress Index
1	0,26
2	0,11
3	0,05
4	0,03
5	0,02
6	0,01

Fig. 1 – Scree plot



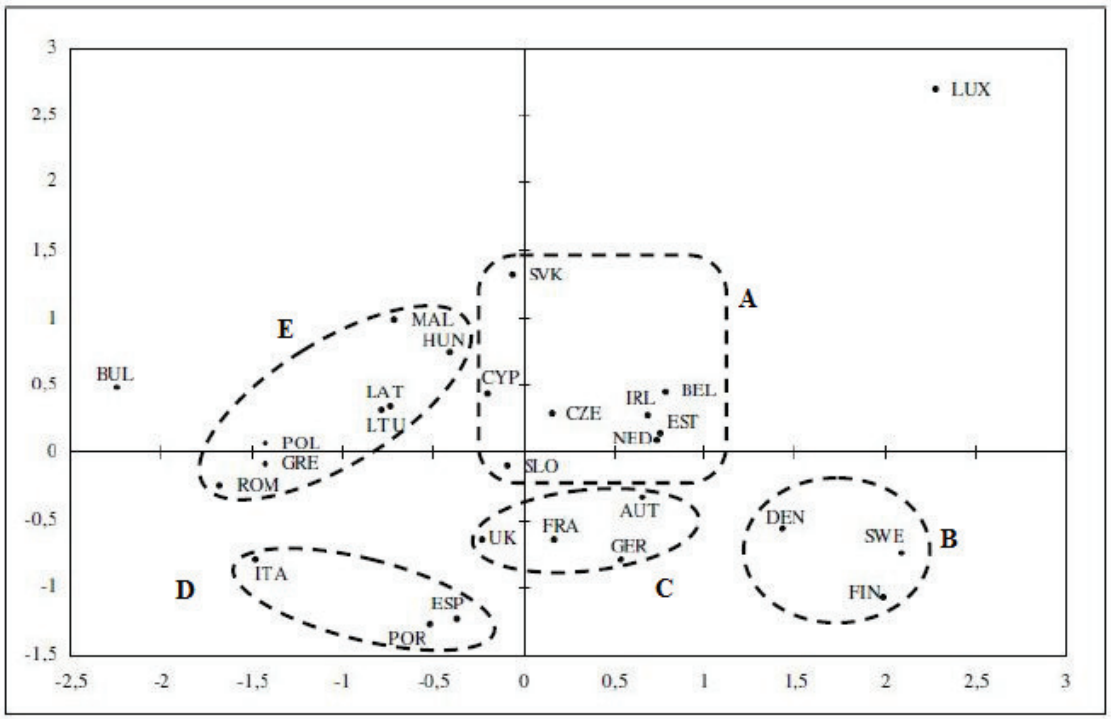
Tab. 2 – Correlations between variables and dimensions

Variables	Dimension 1	Dimension 2
Human resources in science and technology as a share of labour force	0,76	0,01
Research and development expenditure (% of GDP)	0,77	-0,46
Share of government budget appropriations or outlays on R&D	0,46	-0,66
Exports of goods and services (% of GDP)	0,46	0,86
Imports of goods and services (% of GDP)	0,25	0,90
Foreign Direct Investment (FDI) intensity	0,40	0,65
Burden of custom procedures (Rating scale 0-7)	0,90	0,01
Prevalence of foreign ownership (Rating scale 0-7)	0,72	0,24
Prevalence of trade barriers (Rating scale 0-7)	0,81	0,23

The correlations between dimensions and variables (Tab. 2) were useful for naming the axes. The resulting two-dimensional image is shown in Fig. 2. The horizontal axis represents the variables concerning technological progress and trade restrictions, the vertical one the variables related to trade flows. At the bottom of the chart are the Scandinavian cluster (B), which shows high technological values but low volumes of import and export; the grouping of central Europe (C), with levels of technology and trade close to the average values of the sample; and the cluster of Southern Europe (D), which is low on the measures of trade volumes, investment in R&D and human resources in R&D. The two clusters at the top of the chart constitute the best compromise

for the observed variables. Cluster A consists of countries which score fairly in terms of investments in the research field and highly in terms of technological progress and trade flows. The last grouping, cluster E, is made up of mainly Eastern countries which have achieved good positions in the recent past, thanks to grants and funding from EU and domestic investment.

Fig. 2 – Cluster of countries in a two-dimensional space



3. Conclusive remarks

The analysis has shown the relationships between investments in R&D and openness to international trade in the EU member states. The arguments presented above suggest that, under proper conditions, these variables are crucial to secure growth and prosperity of countries.

Among the countries that have most benefited from integration are Eastern European countries, that are rapidly approaching Southern Europe. The economic growth these countries are nowadays experiencing is in turn a useful vehicle for further integration, which is helping fill in the gap between European countries and release the brakes for future joint development.

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Tab. 3 – Database

	Human resources in science and technology as a share of labour force (%) (a)	Research and development expenditure (% of GDP) (a)	Share of government budget appropriations or outlays on research and development (% of total general government expenditure) (a)	Exports of goods and services (% of GDP) (a) (d)	Imports of goods and services (% of GDP) (b) (d)	Foreign Direct Investment (FDI) intensity (Average value of inward and outward FDI flows divided by GDP) (%) (a)	Burden of custom procedures (Rating scale 0-7) (c)	Prevalence of foreign ownership (Rating scale 0-7) (c)	Prevalence of trade barriers (Rating scale 0-7) (c)
Austria	37,8	2,67	1,44	59	52	5,2	5,3	5,6	5,6
Belgium	47,0	1,92	1,36	89	87	22,1	4,6	5,9	5,8
Bulgaria	31,0	0,49	0,85	63	85	10,3	3,6	4,5	4,2
Cyprus	43,7	0,46	0,98	80 (f)	61 (f)	15,6	5,1	4,9	5,4
Czech Republic	37,1	1,47	1,29	80	75	2,4	4,6	5,5	5,9
Denmark	52,3	2,72	1,65	52	51	2,4	5,8	5,7	5,4
Estonia	44,4	1,29	1,62	74	85	6,3	5,5	5,3	5,7
Finland	50,1	3,73	2,01	45	40	-0,7	5,7	6	5,9
France	43,1	2,02	1,43	27	28	5,2	4,8	5,6	5,3
Germany	44,2	2,63	1,81	47	40	2,4	5,1	5,4	5,1
Greece	31,7	0,58 (d)	0,67 (d)	22	35	1	4,1	4,9	5,1
Hungary	33,2	1,00	0,87	80	79	1,7	4,3	6	5,4
Ireland	42,2	1,43	1,24	80 (e)	69 (e)	-1,2	5,1	6,2	5,7
Italy	35,3	1,18	1,30	29	30	1,3	4	4,1	4,8
Latvia	39,9	0,61	0,75	42	61	2,2	4,1	5,2	5,5
Lithuania	42,5	0,80	0,70	54	68	2,3	4,8	4,7	4,8
Luxembourg	45,5	1,62	1,12	173	142	234	5,8	6,2	6
Malta	32,1	0,54	0,42	88	90	6,9	4,8	5	5,4
Netherlands	50,5	1,63	1,52	75	67	0,7	5,2	5,6	5,4
Poland	33,4	0,61	0,70	41	43	1,6	3,9	5,2	4,8
Portugal	23,1	1,51	2,22	33	40	1,2	4,9	4,9	5,5
Romania	23,8	0,58	1,06	31	44	3,5	4,1	4,8	4,8
Slovakia	32,0	0,47	0,79	86	87	1,9	4,7	6,4	5,8
Slovenia	40,1	1,66	1,15	70	71	3	5,4	4,3	5,2
Spain	39,7	1,35	2,43	26	33	4,7	4,4	5,3	4,9
Sweden	49,3	3,75	1,53	52	45	7,2	5,8	6,2	6
United Kingdom	29,9	1,88	1,34	26	29	4,7	4,6	5,9	5,3

(a) Source: Eurostat; (b) Source: World Bank; (c) Source: World Economic Forum; (d) 2007; (e) 2006; (f) Sample average.